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COORDINATION AND ESTABLISHMENT OF CENTRALIZED FACILITIES AND SERVICES OF THE UNIVERSITY OF ALASKA ERTS SURVEY OF THE ALASKAN ENVIRONMENT

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NASA Contract NAS5-21833
ERTS Project 110-1

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16. Abstract

The objective of this project is to provide a focus for the entire University of Alaska ERTS-1 effort (12 projects covering 10 disciplines and involving 8 research institutes and science departments).

During the reporting period activities have been concentrated on the implementation of the project's three primary functions: (1) Coordination and management of the U of A ERTS-1 program, including management of the flow of data and data products; (2) Acquisition, installation, test, operation and maintenance of centralized facilities for processing ERTS, aircraft and ground-truth data; (3) Development of photographic and digital techniques for processing and interpreting ERTS-1 and aircraft data. With minor exceptions these three functions are now well-established and working smoothly.

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I INTRODUCTION

This report summarizes the work performed and conclusions reached during the second six months period, February through July, 1973, of contract no. NAS5-21833, ERTS-1 project no. 110-1, entitled "Coordination and Establishment of Centralized Facilities and Services for the University of Alaska ERTS Survey of the Alaskan Environment."

During the first six months we concentrated on the coordination and management of the University of Alaska ERTS-1 program, including the management of the flow of data products; establishment of centralized technical facilities for processing remotely sensed data, and development of digital and photographic techniques for processing and interpreting these data. This work continued on during the second six months with the perfecting of certain areas of operation and new methods of data interpretation employed.

II STATUS OF PROJECT

A. Objectives

The overall objective of this project is to provide a focus for the entire University of Alaska ERTS-1 effort so as to tie together twelve separately funded projects in ten disciplines, thus channeling multi-disciplinary efforts into an interactive interdisciplinary activity and to achieve significant efficiencies from the sharing of facilities, processing techniques, and contract administration.

B. Accomplishments during the reporting period

Acquisition of Alaskan ERTS data resumed in February 1973 and as of this date we have received approximately one thousand new scenes. These in turn have been sorted and catalogued, our copies filed in the ERTS Data Library and the investigators' copies transmitted to them. An up-to-date map of all fairly cloud-free scenes is maintained and used extensively by both the ERTS investigators and private individuals. Also available in the library are microfilm of all U. S. and Non-U. S. data and a microfilm viewer.

The ERTS darkroom has been in constant use with the processing of hundreds of ERTS images. Much attention was given to the processing and putting together of mosaics which covered large areas of Alaska. Many of these are on display in the ERTS data library and have proven extremely popular as well as very helpful in mapping the state. Many government and private agencies are using this method of mapping areas of particular interest, especially for large scale projects.

A Bausch & Lomb Zoom Transfer Scope has been made available on a temporary loan basis from the U. S Forest Service and is in the ERTS data library for the investigators' use. Many man hours have been spent using the zoom transfer scope and several projects are finding it indispensable This instrument greatly facilitates the transfer of information from small scale ERTS images to larger scale map bases or overlays.

Throughout this reporting period, personnel of project 110-1 were constantly in touch with University investigators, assisting them with the administration of their ERTS contracts, data processing and analysis and interpretation activities as well as in preparation of reports.

The University of Alaska also presented five papers at the ERTS-1 Symposium in March 1973. All were very well received and their results were mentioned in the daily summary sessions as well as Associated Press releases which appeared in Alaskan newspapers. Mr. John M. Miller, co-investigator of project 110-1, presented three of the papers, two of which were authored or co-authored by personnel of project 110-1. The paper by J. M. Miller and Albert E. Belon entitled "A multidisciplinary survey for the management of Alaskan resources utilizing ERTS imagery" was selected as one of four outstanding symposium papers, and at NASA's request, it was presented a second time at a plenary session attended by over 1000 people. This paper is being published by NASA with color illustrations in Vol II, Summary of Significant Results Obtained from ERTS-1.

III NEW TECHNOLOGY

A. VP-8 Image Analyzer

Because of the excessively late delivery of the CDU-200 digital color display unit, the manufacturer in July presented us with the VP-8 Image Analyzer as a token gesture to minimize the impact of the late delivery of the CDU on our ERTS projects. This image analyzer is a color displayed density slicer of unusual flexibility. Not only does it provide a color TV display of the density sliced analog image, but also a single scan display to measure image intensity point-by-point similar to a microdensitometer; a digital readout for position coordinates, intensity measurements, or planimeter measurements of selected density levels; and a pseudo three-dimensional display where the X-Y position information is displayed in isometric projection with the intensity information shown as vertical deflection. The latter feature we assumed to be solely of academic interest for ERTS applications, but Project #12 personnel soon discovered that such manipulation in 3-D indeed is useful to enhance ERTS image lineaments not otherwise apparent by examination on conventional two-dimensioned images.

Of course, the VP-8 Image Analyzer lacks the discriminant power for classification studies that is inherent with the CDU-200 design, and neither does the VP-8 resolution compare favorably with that of digital processing techniques. Radiometrically it is inferior to the CDU-200 design in that it scans a photographic image of a single wavelength band and thereby suffers both from compression of gray scale information, which is inherent in photographic processes, and the inability to allow the investigator to perform interpretation based upon multispectral analyses of ERTS images.

However, the VP-8 has provided a significant forward step in data interpretation to several of our projects at a very critical time. It is especially useful for those projects not necessarily requiring discriminant analysis, such as Project #8, Sea-Ice and Surface Water Circulation; Project #5, Break-Up Characteristics of the Chena River Basin; and Project #4, Seasonal Snow Melt.

We have concluded on the basis of only a few weeks of operating experience with the VP-8 that this instrument is a very desirable addition to our remote sensing data handling facility. It provides new display formats which aid the visual interpretation of images, and it permits quantitative measurements of imaged data with extreme ease compared to manual methods.

The VP-8 arrived with only very rudimentary documentation, but Project No. 110-1 personnel installed the system with little difficulty, thanks to the time previously spent by some of our staff at the ISI plant. Unfortunately, the first two weeks were plagued by component failures in the color TV monitor for which no documentation was available. After obtaining schematics of the monitor as modified by ISI, permanent repairs were made.

Project No. 110-1 personnel quickly familiarized themselves with the operating capabilities of the analyzer, and generated procedures on a crash basis to enable investigators to quickly exploit the VP-8 to their advantage. A demonstration and workshop was presented to the ERTS investigators within two working days after the final repair of the equipment. Time on the analyzer subsequently became in such constant demand that it was necessary to establish advance reservations to avoid conflicts of users.

These procedures generated in-house include density slicing in either linear or logarithmic steps (including logarithmic increasing for white compression or logarithmic decreasing for black compression), area measurements in percent of full image, area measurements in engineering units, point intensity measurements, density distribution measurements, and multispectral density distribution ratios. These procedures are detailed on the following pages to illustrate the flexibility and rather straightforward operating principles. We expect to generate additional procedures as our operating experience grows, and as we have further opportunity to examine new uses for the system.

VP-8 IMAGE ANALYZER APPLICATIONS PROCEDURES

DENSITY SLICING

Accomplish the turn-on procedure and set main function switch to SLICE TEST. Adjust BASE LEVEL and RELATIVE BAND SIZE controls for desired result.

AREA MEASUREMENTS - % OF FULL IMAGE

1. Accomplish the turn-on procedure.

2. Initial status:
   Cap lens
   Main function switch to SLICE VIDEO
   LEVEL SELECTOR switch to BELOW BASE
   DVM switch to AREA
   Set BASE LEVEL clockwise for solid red TV screen
   * Adjust AREA CAL control for a display of +1000 on DVM

3. Uncap lens and readjust BASE LEVEL to desired threshold, and RELATIVE BAND SIZE controls for desired density slicing.

4. Set LEVEL SELECTOR to desired band and read area on DVM as percent of full image.

AREA MEASUREMENT - ENGINEERING UNITS

1. Prepare a black mask accurately calibrated to a convenient measure at the scale of the image being used. (For 1:1,000,000 ERTS transparencies, a 2"x2" square represents 1,000 square miles, or 10 cm x 10 cm represents 10,000 square kilometers).

2. Accomplish the turn-on procedure.

3. Initial status:
   Place calibrated mask on light table
   Main function switch to SLICE VIDEO
   LEVEL SELECTOR to BELOW BASE
   DVM switch to AREA
   Set BASE LEVEL to obtain solid red mask slice on TV screen
   * Adjust AREA CAL control for a display of+100

4. Replace mask on light table with image. Readjust BASE LEVEL and RELATIVE BAND SIZE controls for desired density slicing.

5. Set LEVEL SELECTOR to desired band and read area on DVM in units established by the calibration mask.

W A R N I N G

In making area measurements, be certain the Main Function Switch is NOT in the SLICE TEST position, or the DVM area readouts will include the band area in the test strip as well as the image video.

* NOTE: To test for zero area, set the Main Function Switch to VIDEO ONLY. If the DVM does not read $\pm$ 10, internal adjustments are necessary. Refer to service technician.

APPLICATIONS PROCEDURES

POINT DENSITY MEASUREMENTS

1. Accomplish turn-on procedure.

2. Initial status:
   Cap lens
   LEVEL SELECTOR to BELOW BASE position
   Main Function Switch to SLICE VIDEO
   DVM switch to PT

3. If DVM readout is not ± 15, adjust LVL/PT CAL control for approximate zero reading. (This is a screwdriver-adjusted control on the upper right rear apron of the VP-8.) Leave the other rear controls alone!

4. Center the crosshair on the brightest pixel of the image. For ERTS transparencies, use the clear border area along the right or left edge. For images without a clear border, find the brightest pixel by adjusting the BASE LEVEL control. The last magenta spot on the TV screen to disappear as the BASE LEVEL is adjusted clockwise is the lightest density.

5. Set the brightest pixel for DVM readout of 1,000 by adjusting the lens aperture for coarse approximation. Vernier control to 1,000 can be provided by the VIDEO GAIN control on the rack mounted camera control chasis. Minimize the adjustment of this control--it should not be necessary to move it more than 5^{o}. (This is the only exception to the rule which states no adjustments to controls on rack-mounted equipment.) Repeat steps 3, 4, and 5, until interaction becomes insignificant.

6. Brightness levels now are displayed on the DVM for each pixel that is defined by adjustment of the crosshair.

W A R N I N G

Do not attempt point density measurements with the Main Function Switch in the SLICE TEST mode. In this position the DVM reads the ramp voltage level determined by the VERT CURSOR setting.

LINEAR SLICING

1. Accomplish point density measurement set-up, then set DVM to LEVEL position.

2. Set BAND SIZE MULTIPLIER to minimum, and center at mid-range RELATIVE BAND SIZE controls 1 through 6.

3. Starting with LEVEL SELECTOR switch at BELOW BASE, adjust BASE LEVEL control for DVM display of +125.

4. Set LEVEL SELECTOR switch to position 1 and adjust BAND SIZE MULTIPLIER for DVM display of +250. Then trim bands 2 through 6 by incrementally stepping LEVEL SELECTOR to obtain values +375, +500, +625, +750, +875, and +1000 in order. The display now slices the image into 8 equal width density bands from black to maximum white.

DENSITY DISTRIBUTION MEASUREMENT

1. Accomplish set-up for point measurement, then for linear slicing.

2. Set DVM switch to AREA, and record area of each band by incrementally stepping the LEVEL SELECTOR. The results indicate the density regions that are predominant, intermediate, and infrequent in occurrence throughout the image.

3. To verify validity of the results, the summation of all band areas should approximate 1000, ± 10 counts.

MULTISPECTRAL DENSITY DISTRIBUTION RATIOS

1. Accomplish set-up for point intensity and for linear slicing.

2. Accomplish density distribution measurements for the first spectral image. Then with close registration of second spectral image in position replacing first image, repeat the density distribution measurements.

3. The ratios of the respective band areas for the two images provide clues to the spectral response of the remotely sensed materials. This technique can be expanded to all four ERTS spectral bands, if desired.

4. Another technique for this purpose is to use a color transparency and make density distribution measurements through a sequence of blue, red and green filters, thus providing ratio values of 3 perfectly registered ERTS multispectral bands.

LOGARITHMIC SLICING

1. Accomplish point density measurement set-up, then set DVM to LEVEL position.

2. Set BAND SIZE MULTIPLIER at 3/4 position (a 5-turn control).

3. Set LEVEL SELECTOR switch to BELOW BASE, and adjust BASE LEVEL control for DVM display of +46, or +301, depending upon which type of slicing is desired. Then step LEVEL SELECTOR switch to bands 1 through 6 and adjust RELATIVE BAND SIZE controls 1 through 6 to obtain the following table of values:

Increasing Values		Decreasing Values
Below Base	46	301
1	97	477
2	155	602
3	222	699
4	301	778
5	398	845
6	523	903
Above 6	699	954

4. Image now is color density sliced logarithmically. The increasing values provide white compression, or the decreasing values provide black compression.

B. CDU-200 Color Display Unit

The long awaited digital color display system finally arrived at the very close of this report period. Installation is in progress, and we expect shortly to have an operating system of unusual power for discriminant analysis classification. Only one technical difficulty is foreseen at the present time. The disc memory is noisy on two of its channels. This is bothersome, but not critical, and the source of the noise will be determined and eliminated as time permits.

Throughout the entire nine months that elapsed since delivery of the CDU-200 was first scheduled, we have constantly maintained close liaison with the contractor, Interpretation Systems Inc. We provided counsel, encouragement, and a week each from our design engineer and our computer programmer at the ISI plant in Lawrence, Kansas. We applied the maximum pressure and practical aid that the circumstances would bear, so it is difficult to determine what additional action might possibly have resulted in more prompt delivery.

In retrospect it appears the basic problem was the limited resources available to ISI to carry forward the development of a major system such as the CDU-200 in a timely manner. ISI seemed unable to pursue the inevitable technical difficulties to a timely solution, which threw the production schedule hopelessly off course. The slow response to solving technical difficulties likely was the result of an insufficient number of personnel available for deployment on the CDU program, rather than a lack of basic skills to do the job. We feel now that this firm was too small to undertake the development of this sophisticated system in the time frame that was desirable for our ERTS program.

However, the frustrating and exasperating period of delay in delivery happily has ended, and the CDU-200 still promises to be a very outstanding system totally unmatched in value, efficiency and flexibility by other designs.

IV PLANS FOR NEXT REPORTING PERIOD

August - September 1973

The primary goal, of course, remains the completion of checkout of the CDU-200 digital color display unit. Every effort will be made to achieve an early operational status for this badly needed system. An ISI design engineer accompanied the equipment, and we have asked that he stay as long as necessary both to complete the debugging process and to help familiarize as quickly as possible investigators with the operation of the system. Along with Project 110-1 personnel, the ISI engineer will be available to facilitate the processing and interpretation of the backlog of data from the various projects that awaits manipulation on the CDU. The contribution of the factory engineer beyond the date of formal acceptance of the system will form one contribution of ISI toward offsetting the effects of the late delivery of the system.

Nearly every ERTS project (with the possible exception of Project 110-11, utilizing ERTS as a Teaching Tool in the Department of Geology, and Project 110-12 relating to tectonic studies) has a backlog of digital tapes awaiting display on the CDU-200. This will require heavy participation by software programmers, and the coordination and management activities will be directed toward most effective use of this new facility.

The development of additional computer programs for digital analyses of ERTS tapes on the IBM 360 computer will be accelerated. Operating experience gained from the CDU will be used to guide decisions whether to implement desirable manipulations on the CDU itself or on the IBM 360.

August - January 1974

Coordination and management activities should abate somewhat toward the end of the next six-month period. There always will be some requirement for consultation with individual investigators when specific problems arise with the processing or interpretation of data. Experience thus far has shown that most investigators have become quite competent and innovative in their own right in areas of data manipulation and interpretation. This perhaps is a result of being denied access to the CDU, in lieu of which they have substituted ingenuity and perspiration. However, the advent of the CDU could well spawn a host of new ideas and attendant problems in which Project 110-1 personnel should become engaged.

With the integration of the CDU into our data handling facility, the digital processing facilities finally will be completed.

The photographic data processing facilities and techniques have been established and are completed. Pending any unexpected advances in the state-of-the-art, we plan to continue those processes which have been routinely developed for use by the ERTS investigators. While retaining the best of the present techniques and procedures, along with routine processing of investigator requirements, we will seek to further refine and standardize photographic techniques. Thus far, we have been quite successful in maintaining currency in our photographic workload. One of our goals has been to avoid excessive backlogs or delays in delivering photo products to users, which is a common fault of the major national centers for ERTS products. We will seek to continue achieving this goal, commensurate with the variability of demand and the need to maintain a stable work force in the laboratory.

V CONCLUSIONS

Further experience with the centralized facilities, coordination and management concept of Project 110-1 serves to underscore very heavily our earlier reported conclusion that this approach is indeed very sound, and in

fact quite essential to an integrated, multidisciplinary approach of eleven individual projects. We have successfully achieved an optimum level of shared facilities, services, techniques and results. Through project 110-1 efforts, individual project leaders do talk to one another and share needs and results. It should be noted that the necessary level of coordination to achieve this level of useful results far exceeds the resources authorized by the statement of work agreed in this contract. Our dedication to this concept now has become so strong that in the future we would not consider a similar effort unless directed in the same manner, even if outside funds may not be available for this purpose.

VI RECOMMENDATIONS

We feel impelled to convey once again an earlier criticism of the embarassingly small science-to-administration ratio required by this contract. The level of effort expended tending to administrative matters, such as a plethora of questionnaires, technical and financial reports, and special requests seriously impedes essential activities which lead to achievement of significant results.

VII PUBLICATIONS

(a) In Press:

Belon, A. E., and John M. Miller, Applications of Satellite Remote Sensing to Surveys of the Alaskan Environment and Resources, 1972-73 Annual Report, Geophysical Institute, University of Alaska, to be released September, 1973.

Miller, J. M. and A. E. Belon, A Multidisciplinary Survey for the Management of Alaskan Resources Utilizing ERTS Imagery, Proceedings of NASA ERTS-1 Symposium, Washington, D. C., March 1973.

Anderson, J. H., L. Shapiro and A. E Belon, Vegetative and Geologic Mapping of the Western Seward Peninsula, Alaska, based on ERTS-1 Imagery, Proceedings of NASA ERTS-1 Symposium, Washington, D. C., March 1973.

Miller, J. M. and A. E. Belon, Seeing Alaska from Space, Alaska Magazine, to be published in September 1973.

(b) Published:

Anderson, J. H. and A. E. Belon, A New Vegetative Map of the Western Seward Peninsula, Alaska, Based on ERTS-1 Imagery, Interim Scientific Report on NASA Contract NAS5-21833, University of Alaska, February 1973.

VII REFERENCES - None

APPENDIX A - CHANGE IN STANDING ORDER FORM

None

APPENDIX B - ERTS DATA REQUEST FORMS

February 1, 1973	Data received
April 12, 1973	Data not received
April 12, 1973	Data partially received
April 17, 1973	Data received
April 30, 1973	Data received
May 4, 1973	Data parti ally received
June 4, 1973	Data partially received
July 5, 1973	Data not received

APPENDIX C

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
D
N
ID

DATE July 31, 1973

PRINCIPAL INVESTIGATOR Albert E. Belon

GSFC U318

ORGANIZATION Geophysical Institute, University of Alaska

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*				DESCRIPTORS
	Sea-Ice	Polyna	Land	Snow	
1226-22153	x	x	x	x	
1226-22160	x	x	x	x	
1226-22162	x	x	x	x	
1226-22165	x	x	x	x	
1227-22212	x	x	x	x	
1227-22214	x	x	x	x	
1227-22221	x	x	x	x	
1227-22223	x	x	x	x	
1227-22230	x	x		x	Island
1227-22232	x	x		x	Island
1228-20435	x	x	x	x	Mountains
1241-21580	x	x	x	x	
	Rivers	Lakes	Mtns	Snow	
1218-21305	x		x	x	Sand due
1217-21251	x	x	x	x	
1234-21211	x	x	x	x	
1300-20460	x		x	x	Inlet

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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NASA GSFC
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301-982-5406

GSFC 37-2 (7/72)

APPENDIX D

SEMI-ANNUAL PROGRESS REPORT

UNIVERSITY OF ALASKA
PROJECT 110-1

July 31, 1973

PRINCIPAL INVESTIGATOR: Albert E. Belon/GSFC ID U318

TITLE OF INVESTIGATION: Coordination and Establishment of Centralized Facilities and Services for the University of Alaskan ERTS Survey of the Alaskan Environment

DISCIPLINE: Interpretation technique development

SUBDISCIPLINE: Image Analysis

SIGNIFICANT RESULTS:

1. A Bausch & Lomb ZT-4 Zoom Transfer Scope was obtained for the use of all ERTS project investigators. This is an optical instrument that enables the user to view two separate images simultaneously, such as an ERTS image and a topographical map of the same area. Operating controls permit the difference in scale and image distortions to be compensated for so as to achieve superposition of the images to the viewer. The new information contained in the ERTS image may then be compared to or traced onto the map.

Applications for the Zoom Transfer Scope include most of the disciplines represented by the University of Alaska ERTS projects. It is extremely useful whenever the transfer or comparison of detailed information contained in an ERTS transparency needs to be compared to or transferred to an existing data base. Typical application includes change detection, and the revision and updating, or addition of planimetric data to special purpose maps such as vegetation types or snow cover overlays. It has also been used as an interpretation aid for ERTS images by comparison with aerial photography of the same area.

A special feature of the Zoom Transfer Scope is the anamorphic lens system which can compensate for geometric anomalies in the photographic image or in the map base. Effects of photo image distortion due to tilt, terrain relief, curvature of the earth, differential shrinkage of the base material, and non-1:1 aspect ratios of computer printouts can be eliminated by manipulation of the anamorphic system to enlarge the image in a single direction only.

Funds were not provided by this contract for this instrument. The need for it became so evident while we awaited delivery of the digital color display system that we took two steps of action. First, we succeeded with considerable effort in locating a source of other funds with which to order this instrument. Second, we arranged for a temporary loan of this instrument to us from the U. S. Forest Service in Juneau to provide our investigators access to the instrument pending delivery of our own unit which is scheduled for late August. The Zoom Transfer Scope was in almost constant use through the months of June and July by Projects 2, 3, 4, 5, 7, 8, 13, and 14. It is evident that this instrument will remain a very valuable, although initially unplanned, part of our remote sensing data handling facilities.

2. A second significant result during this period also was initially unplanned and unbudgeted under the activities of this contract. This was the acquisition of the VP-8 Image Analyzer from Interpretation Systems, Inc., (ISI) and this, also, was a fortuitous spinoff from the late delivery of the digital color display system by ISI. To somewhat ease the impact of not having the color display unit (CDU), the manufacturer shipped us without obligation his VP-8 Image Analyzer which utilizes photographic images rather than digitized data. The capabilities of this analyzer include level or density slicing, isodensity contouring, image density measurements, signal level monitoring, pseudo three-dimensional display, and color and monochrome display.

Any single horizontal scan line can be selected for analysis by positioning a horizontal crosshair on the image displayed on the monitor. The image intensity information along this video scan line can then be projected on a X-Y monitor and analyzed similar to a microdensitometer. Any point on this selected scan line can be selected by positioning a vertical crosshair on the image. This point is simultaneously highlighted on the single scan line display on the X-Y monitor, and a built-in digital readout displays the X and Y coordinates and the image intensity at that point.

A level slicing feature allows lines of uniform intensity on the image to be displayed as contours. These contours form the boundaries of bands which are displayed as distinct colors on the color TV monitor.

The VP-8 also provides a pseudo three-dimensional presentation with the X-Y coordinates of the image displayed in isometric projection, and the intensity information is shown as vertical deflection. The effect is similar to viewing a contour or relief model where terrain elevation represents image intensity. Subtle features which are often lost in ordinary level-slicing become apparent when the image is displayed in the 3-D format. The 3-D image can be rotated ± 180 degrees or inclined up to 90 degrees to permit viewing from many angles. The amount of relief can be increased or decreased positively or negatively to obtain the most interpretable display.

In addition, it is possible to expand a small part of the image to full screen size by use of a 5X magnification control. With this feature the user can examine any portion of the image in fine detail, with the monitor display in either of the 3-D, single scan line, or normal monochrome presentation format.